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GREEN PAPER
FROM THE COMMISSION TO THE COUNCIL, THE EUROPEAN PARLIAMENT,
THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE
COMMITTEE OF THE REGIONS

Adapting to climate change in Europe – options for EU action

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Adapting to climate change in Europe – options for EU action

(Text with EEA relevance)

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Note: all figures and maps in this paper are to be printed in colour

1. PUTTING ADAPTATION AND MITIGATION INTO PERSPECTIVE

Climate change presents a double challenge today. First, severe climate change impacts can only be prevented by early, deep cuts of greenhouse gas (GHG) emissions. Swift transition to a global low-carbon economy is therefore the central pillar of the EU's integrated climate change and energy policy in order to reach the EU's objective of keeping global average temperature increase below 2°C compared to pre-industrial levels. Beyond 2°C change, the risk of dangerous and unpredictable climate change increases significantly and costs of adaptation escalate. That is why mitigation is such an imperative for the global community and why EU Heads of State and Government at the 2007 Spring Council unanimously agreed to reduce its greenhouse gas emissions by at least 20% by 2020 and, in case of a global and comprehensive agreement, by 30% by 2020 and called for a global reduction of up to 50 % by 2050 compared to 1990 levels.

Second, with climate change already happening, societies worldwide face the parallel challenge of having to adapt to its impacts as a certain degree of climate change is inevitable throughout this century and beyond, even if global mitigation efforts over the next decades prove successful. While adaptation action has therefore become an unavoidable and indispensable complement to mitigation action, it is not an alternative to reducing GHG emissions. It has its limits. Once certain temperature thresholds are exceeded, certain climate impacts (e.g. major displacement of populations) are expected to become severe and irreversible.

The European Union has to take on the challenge of adaptation, working in partnership with its Member States and globally with partner countries. A European approach is necessary to ensure proper co-ordination and the efficiency of policies that address the impacts of climate change. Adaptation actions must be consistent with mitigation actions and vice versa. These are also necessary to secure the benefits obtained from the Lisbon strategy for growth and jobs.

What is adaptation?

Adaptation actions are taken to cope with a changing climate, e.g. increased rainfall, higher temperatures, scarcer water resources or more frequent storms, at present or anticipating such changes in future. Adaptation aims at reducing the risk and damage from current and future harmful impacts cost-effectively or exploiting potential benefits. Examples of actions include using scarce water more efficiently, adapting existing building codes to stand future climate conditions and extreme weather events, construction of flood walls and raising levels of dykes against sea level rise, development of drought tolerant crops, selection of forestry species and practices less vulnerable to storms and fires, development of spatial plans and corridors to help species migrate. Adaptation can encompass national or regional strategies as well as practical steps taken at community level or by individuals. Adaptation measures can be anticipatory or reactive. Adaptation applies to natural as well as to human systems. Ensuring the sustainability of investments over their entire lifetime taking explicit account of a changing climate is often referred to as 'climate proofing'. *(More adaptation related terms are explained in Annex 5.)*

This Green Paper examines climate change impacts in Europe, the case for action and policy responses in the EU. It focuses on the role of the EU, but takes account of the prominent role of Member State, regional and local authorities in any efficient adaptation strategy. As the adaptation challenge is global by its very nature, the Green Paper also raises the external dimension and looks at adaptation measures in Europe that could also apply to other parts of the world, and the opportunity for the EU to provide international leadership in this area. The recent G8 Summit at Heiligendamm welcomed the adoption of the Nairobi work programme on adaptation and emphasised the participants' commitment to enhance cooperation with and support for developing countries in this area.

2. REASONS FOR GLOBAL CONCERN

Many areas in the world are already struggling today with the adverse effects of an increase in global average temperatures of 0.76 °C since 1850. Without an effective global climate change mitigation policy, best estimates for global warming in the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 4AR, Working Group I) range from 1.8°C to 4°C compared by 2100 to 1990 levels (see Annex 1). This is three to six times the temperature increase the globe has experienced since pre-industrial times. Even the low end of a business as usual scenario would take the temperature rise since pre-industrial times above 2°C. The Annex to this Green Paper explains the temperature changes and global impact in more detail.

Over the last three decades climate change has already had a marked influence on many physical and biological systems worldwide:

- **Water:** Climate change will further reduce access to safe drinking water. Glacier melt water currently supplies water to over a billion people; once it disappears, populations will be under pressure and are likely to migrate to other regions of the world, causing local or even global upheaval and insecurity. Drought-affected areas are likely to increase.
- **Ecosystems and biodiversity:** Approximately 20 – 30 % of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5 – 2.5°C.
- **Food:** Climate change is expected to increase the risk of famine; the additional number of people at risk could rise to several hundred millions.
- **Coasts:** Sea level rise will threaten the Nile delta, the Ganges/Brahmaputra delta and the Mekong delta and displace more than 1 million people in each delta by 2050. Small Island states are already affected.
- **Health:** Climate change will have direct and indirect impacts on human and animal health. The effects of extreme weather events and an increase in infectious diseases are amongst the most important risks to be taken into account. Climate-sensitive diseases are among the most deadly worldwide. Diarrhoea, malaria and protein-energy malnutrition alone caused more than 3.3 million deaths globally in 2002, with 29 % of these deaths occurring in Africa.

3. EUROPE WILL NOT BE SPARED

The effects of climate change in Europe and the Arctic are already significant and measurable. Climate change will heavily affect Europe's natural environment and nearly all sections of society and the economy. Because of the non-linearity of climatic impacts and the sensitivity of ecosystems, even small temperature changes can have very big effects. The impacts in Europe's major geographical regions are described in Annex 3.

Europe has warmed by almost 1°C in the last century, faster than the global average. A warmer atmosphere contains more water vapour but new precipitation patterns differ strongly from one region to another. Rainfall and snowfall has significantly increased in northern Europe, whereas droughts are more frequently observed in Southern Europe. Recent temperature extremes, such as the record-breaking 2003 summer heat wave are consistent

with man-made climate change. While single weather events cannot be attributed to a single cause, statistical analyses have shown that the risk of such events has already increased considerably as a consequence of climate change. There is overwhelming evidence that almost all natural, biological and physical processes (e.g. trees are blossoming earlier, glaciers are melting) are reacting to climatic changes in Europe and worldwide. More than half of Europe's plant species could be vulnerable or threatened by 2080.

The most vulnerable areas in Europe are (see Figure 1 and 2):

- Southern Europe and the entire Mediterranean Basin due to the combined effect of high temperature increases and reduced precipitation in areas already coping with water scarcity.
- Mountain areas, in particular the Alps, where temperatures increase rapidly leading to widespread melting of snow and ice changing river flows.
- Coastal zones due to sea level rise combined with increased risks for storms.
- Densely populated floodplains due to increased risks for storms, intense rainfall and flash floods leading to widespread damages to built-up areas and infrastructure.
- Scandinavia where much more precipitation is expected and a larger part in the form of rain instead of snow.
- The Arctic region where temperature changes will be higher than in any other place on Earth.

Many economic sectors depend strongly on climatic conditions and will feel the consequences of climate change on their activities and businesses directly: agriculture, forestry, fisheries, beach and skiing tourism, and health. Reduced water availability, wind damages, higher temperatures, increased bushfires and greater disease pressure will lead to damage to forests. Increase in frequency and intensity of extreme events such as storms, severe precipitation events, sea floods and flash floods, droughts, forest fires, landslides cause damage to buildings, transport and industrial infrastructure and consequently impact indirectly on financial services and insurance sectors. Even damage outside the EU could significantly affect its economy, e.g. reduced timber supply to European processing industries.

Changing climate conditions will for instance affect the energy sector and energy consumption patterns in several ways:

- In regions where precipitation will decrease or where dry summers will become more frequent, water flow for cooling of thermal and nuclear power plants and for hydropower production will reduce. The cooling capacity of water will also decrease because of the general warming of water and discharge thresholds may be crossed.
- River flow regimes will be altered due to changed precipitation patterns and in mountain areas due to reduced ice and snow cover. Silting of dams for hydropower may accelerate due to increased risks of erosion.
- Demand for heating will drop but the risk of power disruptions will raise as summer heat pushes up demand for air-conditioning resulting in an increased demand for electricity.
- Increased risk for storms and floods may threaten energy infrastructure.

Major transport infrastructure with long lifetimes such as motorways, railways, waterways, airports, ports and railway stations, its functioning and related means of transport are weather and climate sensitive and therefore affected by a changing climate. For example:

- Sea-level rise will reduce the sheltering effect of breakwaters and quays wall.
- Risks for damage and disruption due to storms and floods but also due to heat waves, fires and landslides are generally expected to increase.

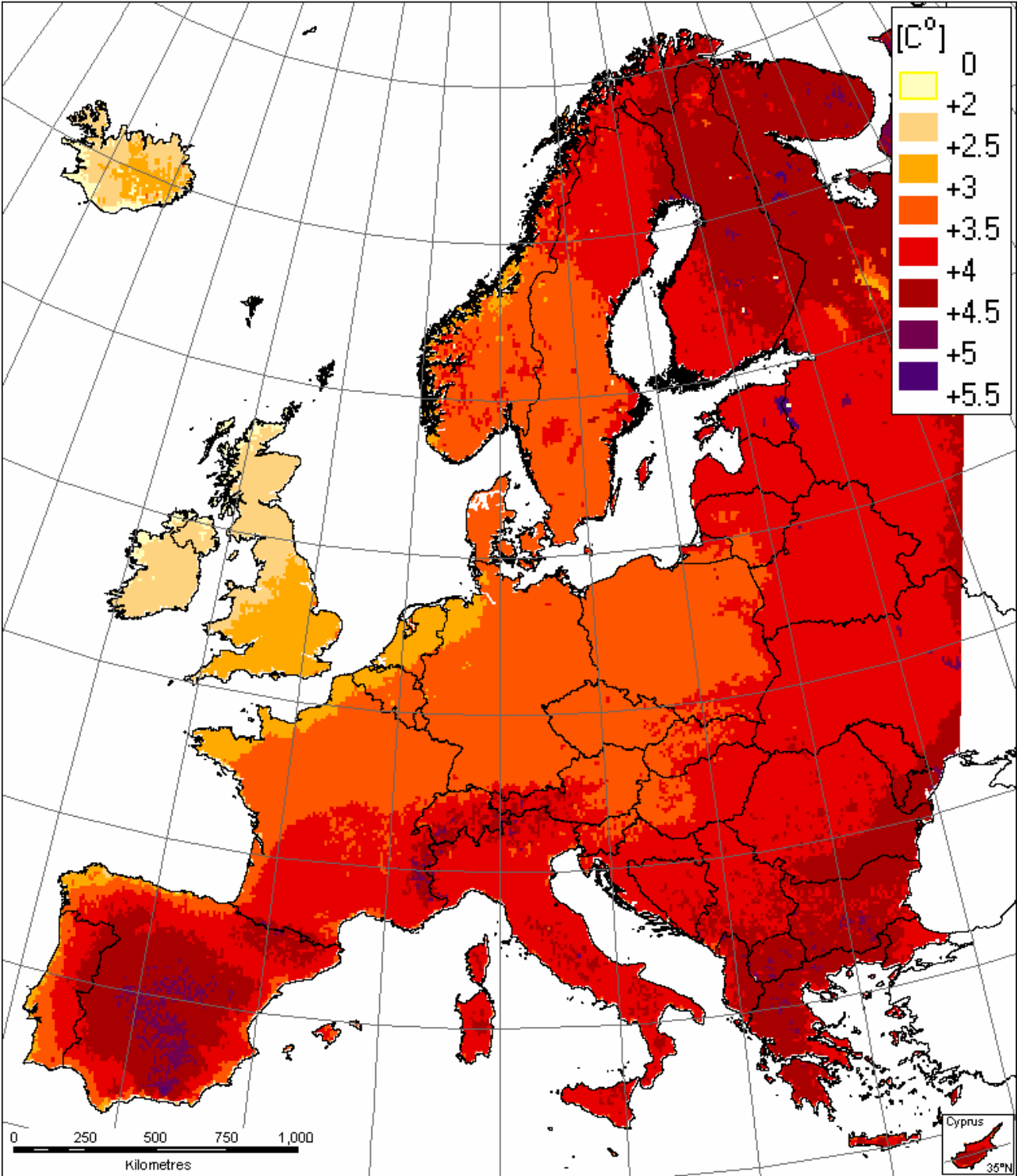
This demonstrates that, whilst there may be some positive aspects of climate change (eg agricultural production in some limited parts of Europe), these are by far exceeded by negative impacts.

Key questions:

- 1) What will be the most severe impacts on Europe's natural environment, economy and society?
- 2) Which of the adverse effects of climate change identified in the Green Paper and its Annex concern you most?
- 3) Should further important impacts be added? If yes, which ones?

Figure 1: Change in mean annual temperature by the end of this century¹

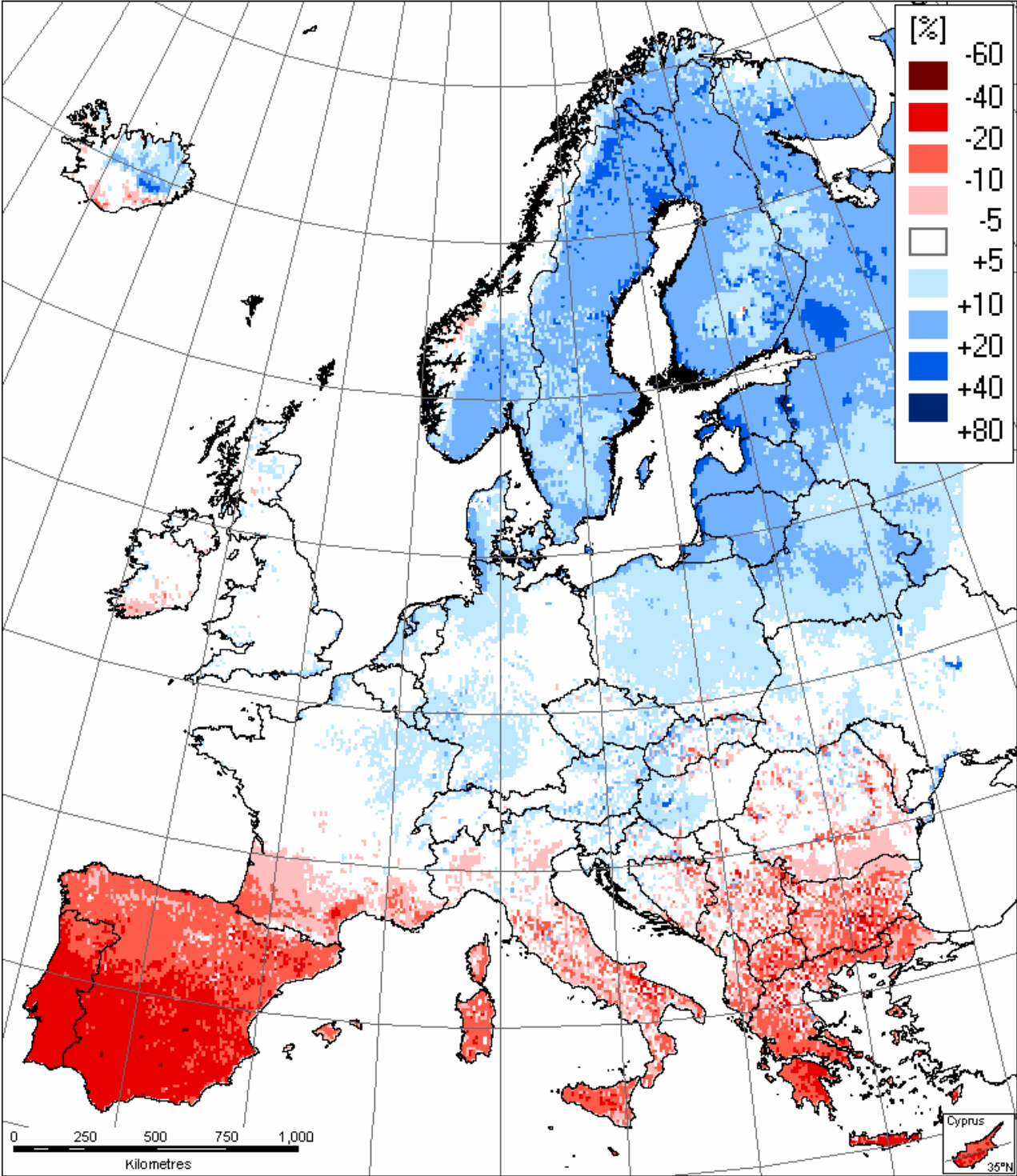
Temperature: change in mean annual temperature [C°]



¹ Figures 1 and 2 are based on IPCC SRES scenario A2. The projected climate impacts are estimated for 2071-2100 relative to 1961-1990. The maps are based on DMI/PRUDENCE data (<http://prudence.dmi.dk>), and processed by JRC within the JRC funded PESETA study (<http://peseta.jrc.es>)

Figure 2: Change in mean annual precipitation by the end of this century

Precipitation: change in annual amount [%]



4. EUROPE MUST ADAPT - CHALLENGES FOR EUROPEAN SOCIETY AND EUROPEAN PUBLIC POLICY

The case for action – saving on future costs

The Stern review² on the economics of climate change concludes that adaptation could reduce the costs, provided policies are put in place to overcome obstacles to private action. Market forces alone are unlikely to lead to efficient adaptation because of a certain degree of uncertainty in the climate projections and lack of financial resources. Cost-effective adaptation is therefore the most appropriate solution.

Preliminary estimates from the Stern review suggest that, with a 3-4°C global average temperature rise, the additional costs of adapting infrastructure and buildings could already amount to 1-10% of the total costs invested in construction in OECD countries. The additional cost of making new infrastructure and buildings more resilient to climate change in OECD countries could range from \$15-150 billion each year (0.05–0.5% of GDP). If temperatures are allowed to rise by 5-6°C, the costs of adaptation measures are likely to rise sharply, and indeed their relative effectiveness then diminishes.

As shown in Figure 3, damage caused by sea-level rise without adaptation can be up to four times higher than the costs with additional flood defences. With no action, damage costs increase steeply from 2020s until 2080s.

When to adapt?

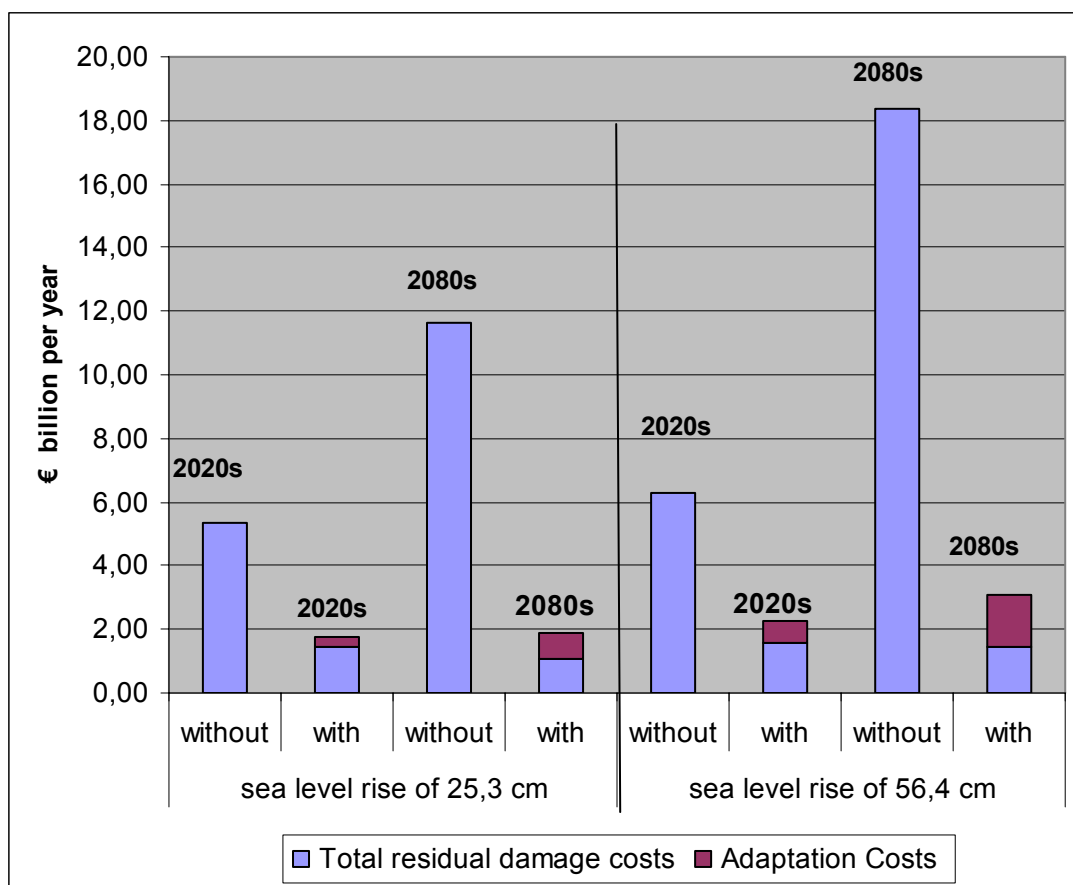
Early action will bring clear economic benefits by anticipating potential damages and minimizing threats to ecosystems, human health, economic development, property and infrastructure. Furthermore competitive advantages could be gained for European companies that are leading in adaptation strategies and technologies.

Sufficient knowledge on time dimensions of impacts is important when setting priorities. The exact level of temperature increase is uncertain and will also depend on global mitigation action taken over the next few decades. This is particularly the case for the longer time frames for which uncertainties are larger.

If there is no early policy response, the EU and its Member States may be forced into reactive un-planned adaptation, often abruptly as a response to increasingly frequent crises and disasters, which will prove much more costly and also threaten Europe's social and economic systems and its security. For impacts where we have enough confidence in the forecasts, adaptation must therefore start now.

² http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm

Figure 3: Impact of adaptation measures on damage due to low and high sea level rise. Costs with and without adaptation measures³



How should Europeans adapt?

EU private sector, businesses, industry and services' sectors, as well as individual citizens will be confronted with the consequences of climate change and can play an important role in adaptation measures. Concrete action could range very widely, covering e.g.:

- Soft, relatively inexpensive measures, e.g. water conservation, changes in crop rotations, sowing dates and use of drought tolerant crops, public planning, and awareness raising.
- Costly defence and relocation measures, e.g. increasing the height of dykes, relocating ports, industry and entire cities and villages from low-lying coastal areas and flood plains, and building new power plants because of failing hydropower stations.

Action is needed by the public sector, e.g. adapting spatial and land use planning to risks of flash floods; adapting existing building codes ensuring that long-term infrastructure will be proof to future climate risks; updating of disaster management strategies, early flood and forest fire warning systems.

Adaptation will also bring about new economic opportunities including new jobs and markets for innovative products and services such as:

³ IPCC SRES scenario A2; costs by 2100 in 1995 €. Results from EC JRC PESETA study.

- New markets for climate-proof building techniques, material and products.
- Beach tourism in Mediterranean countries would be expected to shift to spring and autumn where tourist resorts may become too hot during summers, while favourable climate conditions during summer would turn the Atlantic and North Sea into potential new tourist destinations for beach holidays.
- Adapting local agricultural management practices in Scandinavia to longer growing seasons.
- Insurance sector could develop new insurance products for reducing risks and vulnerability before disasters strike. Insurance premiums anticipating climatic changes could provide incentives for private adaptation actions.

The role of Member States, regional and local authorities

Adaptation is complex because the severity of the impacts will vary from region to region, depending on physical vulnerability, the degree of socio-economic development, natural and human adaptive capacity, health services, and disaster surveillance mechanisms.

Multilevel governance is therefore emerging on climate change adaptation involving all actors from the individual citizens and public authorities to the EU level. Action should be taken at the most appropriate level and be complementary, based on joint partnerships. Division of competence between states and their regions varies significantly across the EU and the examples below should therefore be adapted to the national situation. Many of the examples would anyhow require close coordination between and involvement of national, regional and local authorities and other authorities such as river basin administrations.

- National level

Improving disaster or crisis management

The frequency and intensity of major large-scale disasters such as fires, landslides, droughts, heat waves, floods or outbreaks of disease will increase. Disaster prevention, preparedness, response and recovery should become even more of a priority for Member States. Rapid response capacities to climate change would need to be accompanied by a strategy for disaster prevention and alert both at national and European level.

Risk management tools could be further strengthened and new tools developed: for example mapping of vulnerable areas in accordance with the types of impacts, development of methods and models, hazards assessment and forecasting, assessment of health, environmental, economic and social impacts, satellite and earth observation in support of risk management technologies. Experience and good practice including contingency planning could be shared.

Developing adaptation strategies

Experience and expertise in designing effective adaptation strategies and implementing policies is still limited. Information-sharing on adaptive response measures could greatly reduce learning costs across Member States, regions, municipalities, and communities.

The poorer segments of society will be more vulnerable to the changes. Attention therefore needs to be paid to the social aspects of adaptation, including threats to employment and impact on living and housing conditions. For example, young children and elderly are more vulnerable to heat waves.

- Regional level

Adaptation to climate change constitutes a challenge for planning authorities in Europe, notably at regional level. Spatial planning is a cross-sectoral issue which makes it a suitable tool to define cost-effective adaptation measures. Minimum requirements for spatial planning, land use and land use change, with respect to adaptation could play a key role for awareness raising among the public, decision makers and professionals and for triggering a more proactive approach at all levels. The development of specific technical guidance documents and case studies and good practice could be considered. EU support for implementation could be provided to regions for exchanging good practices.

- Local level

Many decisions influencing directly or indirectly climate change adaptation are taken at the local level. This is also where detailed knowledge on the local natural and human conditions is available. Therefore local authorities have an important role to play. Behavioural change within societies and communities depends largely on awareness of the problem. Citizens and actors may not yet be aware of the scale and magnitude of what is to come as well as their impacts on their activities.

For example detailed land management and land use practices could be explored in partnership with farmers to prevent erosion and mud streams reaching houses and settlements. In Southern Europe some municipalities have developed, together with the farmers, initiatives for saving water through electronic management and distribution systems for irrigation of crops.

In regions with rising rainfall and rainfall spells, separate collecting systems for sewage and stormwater could be considered to reduce the otherwise increasing need for sewage overflows.

Why is action needed at EU level?

There are clear benefits in approaching adaptation in an integrated, coordinated manner at EU level. Europe's physical, biological and human systems are very rich in diversity and climate change will magnify this. Whilst a "one-size-fits-all" approach to adaptation is clearly not appropriate, climate change will nevertheless impact everywhere and those impacts will not follow administrative boundaries. In many areas adaptation will require a cross-boundary approach, e.g. on river basins and bio-geographic regions. While measures will have to be taken or implemented at a national or local level, where operational capacities exist, it is essential that efforts be co-ordinated in a cost-effective manner. Actors will need to be mobilised at all levels.

Furthermore, certain sectors (e.g. agriculture, water, biodiversity, fisheries, and energy networks) are largely integrated at EU level through the single market and common policies and it makes sense to integrate adaptation goals directly into them. It could also be considered how adaptation can be taken into account in EU spending programmes (e.g. research, cohesion, trans-European networks, rural development, agriculture, fisheries, social fund, external actions and the European Development Fund). Adaptation will require solidarity among EU Member States in order to ensure that the poorer and disadvantaged regions and those regions that will be hit hardest by climate change will be able to take the necessary measures.

Adaptation policies are emerging in nearly all Member States. It is essential to share experiences from early adaptation action and results from research. Adaptation to climate

change is likely to benefit from experience gained in reaction to extreme climate events and from implementation of specific and proactive climate change risk management plans.

Europe has the human capacity, technical skills and financial resources to take a strong leadership role. Adaptation is largely a question of political coherence, forward planning and consistent and coordinated action. The EU should show how adaptation is to be taken into account in all the relevant EU policies. The EU can thus set an example and intensify its co-operation with its partners around the globe in adapting to this global threat.

This Green Paper focuses on a first and most urgent set of options for priority actions at Community level within the sphere of Community competence. In this context four lines of action can be considered.

- Where current knowledge is sufficient, adaptation strategies should be developed in order to identify optimal resource allocation and efficient resource use which will guide actions at EU level, through EU sectoral and other policies and the available Community Funds.
- The EU needs to recognise the external dimension of impacts and adaptation and to build a new alliance with its partners all around the world and particularly in developing countries. Adaptation action should be coordinated with its neighbours and cooperation with international organisations should be further strengthened.
- Where there are still important knowledge gaps, Community research, exchange of information and preparatory actions should further reduce uncertainty and expand the knowledge base. Integration of research results into policy and practice should be reinforced.
- Coordinated strategies and actions should inter alia be further analysed and discussed, in a European Advisory Group on Adaptation to Climate Change under the European Climate Change Programme.

Under each of these four main headings a number of priority options for action at EU level are outlined below for further consideration.

Key questions:

- 4) Does the green paper place the right urgency and emphasis on the matter of adaptation in Europe?
- 5) What should be the different roles of EU, national, regional, local authorities and the private sector?
- 6) Which economic, social and environmental impacts of climate change should be addressed at EU level as a matter of priority?
- 7) Apart from the main priority areas identified in the four-action approach, are there other areas that have been missed out? If yes, which?

5. FOCUSING EU ACTION – PRIORITY OPTIONS FOR A FLEXIBLE FOUR-PRONGED APPROACH

5.1. The first pillar: Early action in the EU

Early action covers policy options in the following areas:

- Integrate adaptation when implementing and modifying existing and forthcoming legislation and policies
- Integrate adaptation into existing Community funding programmes
- Develop new policy responses

5.1.1. Integrate adaptation when implementing existing and upcoming legislation and policies

Adaptation to climate change will impact on many EU policy areas. The following provides an initial overview of how adaptation to climate change has or can be taken into account in these policies. As many of the policies are based on framework legislation, the success of the EU's approach to adaptation depends on enhanced co-operation during implementation among Member States and between the EU and Member States.

Agriculture and rural development

European agriculture will face many challenges over the coming years such as international competition, further liberalisation of trade policy and population decline. Climate change will add to these pressures and will make the challenges more difficult and costly. The projected climate changes will affect crop yields, livestock management and location of production with important risks for farm income and land abandonment in certain parts of Europe. Food production risks could become an issue in certain parts of Europe as heat waves, droughts and pests are likely to increase the incidence of crop failures. As yield variability increases, the global food supply will be at increasing risk. In this context, the potential impact of the possible increase of biomass for energy production on the global food supply should be assessed.

Under a changing climate, the role of EU agriculture and forestry as providers of environmental and ecosystem services will further gain importance. Agricultural and forestry management have a major role to play regarding, among others, efficient water use in dry regions, protection of water courses against excessive nutrient inflow, improvement of flood management, maintenance and restoration of multifunctional landscapes such as high nature value grassland that provide habitat and assist migration for numerous species. Promotion of climate resilient forest management, soil management measures related to maintenance of organic carbon (e.g., no or minimum tillage) and protection of permanent grasslands are mitigation measures that should also help adaptation to climate change risks.

Community support to agriculture, forestry and rural development plays an important role in food production, the maintenance of rural landscapes and the provision of environmental services. The recent reforms of the Common Agricultural Policy (CAP) have been a first step towards a framework for the sustainable development of EU agriculture. Future adjustments of the CAP and the 'Health check' of 2008 could provide opportunities to examine how to better integrate adaptation to climate change in agriculture support programmes. It should for instance be considered to what extent the CAP can promote good farming practices which are

compatible with the new climate conditions and which contribute proactively to preserving and protecting the environment.

Industry & services

EU industry and services' sectors will be confronted both with the need to adapt to climate change and opportunities to bring to market the products and services to assist this process. Climate change will affect industries and services like construction and tourism, may provoke restructuring and create damage to industrial infrastructure. Companies will need to adapt to changing conditions for example by integrating climate change adaptation needs into their business plans. At the same time, co-benefits between mitigation and adaptation measures should be exploited. For example investments in insulation do not only reduce the need for heating in winter but protects against heat and limits the need for air-conditioning during warmer summers.

In the forthcoming mid-term review, the Commission will examine how industrial policy can contribute to adaptation efforts. It will be followed by an Action Plan in early 2008.

Energy

Changing climate conditions opens new opportunities such as for solar and photovoltaic energy. On the other hand, longer and drier summers could affect other energy sources, such as nuclear power and hydro power, while at the same time increasing the need for electricity for air-conditioning. This underlines the need for diversification of energy sources, development of renewable energy, increased demand-response management and a grid that can cope with greater fluctuations in both electricity demand and production. The Commission is working towards a Strategic Energy Technology Plan which will aim to accelerate innovation of energy technologies to match the double challenge of climate change mitigation and adaptation. A key issue is buildings. These are prime examples of the immediate need for adaptation, to make them more liveable in a hotter climate, and to reduce the energy demand, which will also address mitigation. The Commission will start work on revising the relevant regulatory framework in the near future, in particular the Directive on energy performance of buildings.

Transport

Adapting existing transport infrastructure to changing climate conditions, while ensuring its continued and safe functioning, will require substantial additional investments. New transport infrastructure and related transport means should be made climate proof from the early design phase. For example, the variation in hydraulic regime and water level along navigable rivers has already had an impact on the architecture of inland water boats. Sound planning, including the spatial aspects of site selection, should take into account expected future climate conditions. Guidance on the interpretation of the existing community framework for port authorities and managers of waterborne infrastructures would also be helpful for the adaptation of such infrastructure.

Health

Climate change clearly has detrimental impacts on health through heat waves, natural disasters, air pollution and infectious vector-borne diseases. In addition, waterborne, food borne and zoonotic diseases in humans can potentially be affected by climate change. These effects can be amplified by other stressors, e.g. exposure to ozone and fine particles during a heat wave. Long-term exposure to fine particles in ambient air worsens a number of health problems such as chronic obstructive pulmonary disease, which makes people more susceptible to further climate-induced stress. Various projects developed under EU funding programmes (in particular the Community Public Health Programme and the Research Framework Programmes) have focused on the effects of heat waves on human health, public health responses, the prevention of acute health effects due to other weather conditions and adaptation strategies for health. The mid-term review of the European Environment and Health Action Plan (2004-2010) also includes recommendations for appropriate actions.

Animal health is very likely to be affected by impacts on living conditions and by the potential increase of transmissible infectious diseases. Climate change may directly or indirectly impact animal vector-borne diseases.

Adaptation is a key response strategy to make sure that the potential effects of climate change on health are reduced and kept to a minimum. The European Commission recognises that such effects are rapidly and dangerously increasing. It is therefore planning to adopt a Communication in 2008 focusing specifically on this issue, which will establish a framework to tackle the impact of climate change on human and animal health. The Communication is expected to look at different aspects of mortality and morbidity due to climate change including the changes in the means of transmission of certain infectious diseases affecting human and animals; changes in the dissemination of airborne allergens due to atmospheric changes and the risks due to ultraviolet radiation as climate change delays the recovery of the stratospheric ozone layer.

Consumer protection, public health and food and feed regulations will have to be screened and "proofed" against climate sensitivity. The Commission may call upon its EU Scientific Committees and Agencies to inform about specific health risks associated with climate change.

Water

The Water Framework Directive provides a consistent framework for integrated water resources management. It does not however address climate change directly. The challenge will be to incorporate measures to cope with climate change as part of its implementation, starting with the first planning cycle for 2009. In particular, economic instruments and the user pays principle should be applied across all sectors, including households, transport, energy, agriculture, and tourism. This will provide strong incentives to reduce water consumption and increase efficiency of use.

The Commission is working on a Communication on water scarcity and droughts which is closely linked to climate change and adaptation. Some regions of Southern Europe, where freshwater resources are already scarce, will suffer. Droughts could become more frequent across the entire EU and water quality will deteriorate. Sustainable demand management is of

utmost importance throughout the EU. Inadequate water pricing, inconsistent land-use planning and bad water allocation automatically lead to overuse. Applying efficient pricing policies, making water-saving a priority and improving efficiency in all sectors are already essential elements of the EU's approach.

Likewise, the proposed legislation on the assessment and management of floods will focus on prevention, protection and preparedness. Implementation should include assessing the extent of possible extreme events in the future in order to reduce risks. Soft non-structural measures should be prioritised, i.e. using natural processes to the maximum to reduce flood risks e.g. working with wetlands, maximising retention capacities at source, sustainable land use and spatial planning limiting exposure and vulnerability. However, hard structural flood defences will continue to be important to cope with extreme flooding.

Marine and fisheries

In the context of its work on the EU Maritime Policy, the Commission will examine climate change issues. The Marine Strategy and related legislation, which will constitute the environmental pillar of the Maritime Policy, will integrate climate and adaptation measures into implementing programmes and plans.

It is an important objective of the Common Fisheries Policy to ensure sustainability of fishing stocks. Climate change can affect the distribution patterns and abundance of species from plankton to top predators, which may result in major changes in ecosystem functions and geographical ranges in stocks. Important changes in water temperatures might also have an impact on aquatic animal farming. The necessary adaptation measures should be fully reflected in the implementation of current programmes.

Ecosystems and biodiversity

Climate change will significantly affect economies and societies through its impacts on ecosystems, more specifically on natural capital, biodiversity and the flow of ecosystem services in terrestrial, freshwater and marine ecosystems. This is because the impacts of climate change on man are largely mediated by natural systems. Healthy ecosystems will be more resilient to climate change and so more able to maintain the supply of ecosystem services on which our prosperity and wellbeing depend. They lie at the centre of any adaptation policy. Consequently 'conventional' pressures that cause the fragmentation, degradation, over-exploitation and pollution of ecosystems must be reduced ('ecosystem climate-proofing').

Climate change will have profound impacts on the physical and biological components of ecosystems: water, soil, air and biodiversity. For each of these areas EU legislation and policies are in place, or in the pipeline. They will need to be implemented on schedule to allow early action to strengthen ecosystem resilience to climate change. However, it will be a major challenge to maintain healthy, functioning ecosystems, as a changing climate could undermine past and present efforts. Thus policies may need further adjustment.

Effective implementation of the 2006 Biodiversity Communication and its 'EU Action Plan to 2010 and beyond' will make an important contribution to safeguard and restore biodiversity and ecosystems. Emphasis must be placed on: ensuring the integrity, coherence and

connectivity of the Natura 2000 network; conserving and restoring biodiversity and ecosystem services in the wider countryside and marine environment; making regional and territorial development compatible with biodiversity; reducing the undesirable impacts of invasive alien species.

Sustainable use means that development and exploitation should not result in a decline in natural capital or ecosystem services. In this context, compensatory measures are important to ensure that development projects preserve the natural capital. Comprehensive cost/benefit analysis and impact assessments should gradually and systematically internalise the environmental costs of declining ecosystems.

Other natural resources

The 2003-2006 Forest Focus programmes include studies on predicting changes in forest growth, carbon stocks and tree species migration. Community-wide forest and soil monitoring programmes must be supported as their results should be used as a basis for the development of response measures. The Forest Action Plan includes research and training on adaptation, assessment of impacts, and exchange of practices, and promotes more carbon-conscious forest management, similar to soil management in terms of both mitigation and adaptation.

The Soil strategy and its related legislation aims to protect soil functions across the EU. Areas at risk of organic matter decline will have to be identified so that climate change can be taken into account in the programmes designed to reverse unsustainable trends. Net loss of soil organic matter in a warming climate is a major concern as soil is the largest terrestrial pool of carbon.

The Thematic Strategy on the sustainable use of natural resources aims to reduce the negative impacts of resource use in a growing economy and improve resource efficiency, taking a life-cycle approach. Climate change makes natural resources scarcer and aggravates the environmental impacts of resource use. The forthcoming Sustainable Consumption and Production Action Plan will consider actions to improve the coherence of existing policies and to use less resources and energy.

Cross-cutting issues

Climate-proofing must be integrated into the Environmental Impact Assessment (EIA) Directive and the Strategic Environmental Assessment (SEA) Directive. EIAs, SEAs and policy impact assessments must address impacts on ecosystems supported by instruments that internalise the costs of damages to natural capital and ecosystem services.

Member States and EU civil protection mechanisms should focus more on prevention, early warning and preparedness.

The Integrated Coastal Zone Management (ICZM) Recommendation calls for a strategic approach to coastal planning and management. Coastal zones are increasingly exposed to climate change risks and should be a major focus of mitigation and adaptation measures. A coherent and integrated approach to coastal planning and management should provide a context for synergies and address potential inconsistencies between economic development of coastal zones and necessary adaptation to climate change. Guidance should be given for

planning and management, and the best principles and practices should be applied when developing approaches and strategies.

5.1.2. Integrate adaptation into existing Community funding programmes

When preparing their programmes for Community support, Member States should integrate adaptation activities. This is particularly relevant for infrastructure projects. Major infrastructure such as bridges, ports and motorways have lifetimes of 80-100 years, so today's investments must take full account of the conditions projected for the end of the century. Buildings and other infrastructure designed to last 20-50 years will also have to withstand future climate conditions. Investments that are optimal under current conditions may not necessarily be economically viable under future climatic conditions or when their impacts on the health of ecosystems are taken into account. Therefore medium and long-term investments should be "climate proof". For example, in The Netherlands state-of-the-art knowledge on effects of climate change on river flows and sea level rise is already taken into account in infrastructure design. In the US architects assume a one metre sea level rise when designing bridges in coastal areas.

The Fourth Cohesion report highlighted the importance of climate change in EU cohesion policy.⁴ The Commission will examine how climate proofing can be reflected and made operational in the programmes and projects adopted under the Cohesion Fund, Regional Development Fund (e.g. as part of Regional Innovation Strategies), pre-accession instruments, Trans-European Networks Programmes, and infrastructure measures under the Rural Development Fund.

The European Social Fund foresees a wide range of actions that have a major role to play in raising public awareness for climate change, building capacity, training, and whenever people are forced to move. Examples of such actions could be a training programme for architects on the climate-proofing of buildings, new job opportunities for youngsters in a low-carbon economy, or preventive health care for children and the elderly in the event of heat waves. Member States should already take advantage of the current operational programmes to include such measures.

The Fisheries Structural Fund sets out the policy priorities and the terms of assistance for the fisheries and aquaculture sector. It is designed to help achieve the aims of the common fisheries policy by providing structural assistance. It thus strengthens the competitiveness of the operating structures and the development of economically viable enterprises. Climate change impacts should increasingly be taken into account.

LIFE+ should fund pilot projects promoting adaptation across national borders, for example demonstrating cost-efficient adaptation technologies, innovative approaches, spatial planning for adaptation, and exchange of good practice. Furthermore, it should support sustained communication and raise public awareness about climate impacts and adaptation.

This Green Paper provides an opportunity to examine to which extent climate change, and in particular adaptation needs, are appropriately dealt with in the existing funding programmes.

⁴ http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/cohesion4/index_en.htm

5.1.3. Develop new policy responses

There are several Community policies that will be directly or indirectly affected by the impacts of climate change and for which the EU still needs to develop an appropriate response. For these policies, the Commission should consider providing appropriate incentives for cost-effective adaptation. A systematic check of how climate change is going to impact on all Community policy areas and legislation should be conducted by 2009 and followed up with further concrete action.

As a matter of example, targeted action is needed on building codes and methods, and climate-resilient crops. Adaptation is also an opportunity for innovation and new technologies, with a growing potential for exporting technological solutions developed in the EU. This should be explored in close co-operation with the private sector.

Climate change and the effects it generates in terms of property damage, business interruption and forest fires presents a substantial financial risk for individuals, companies and the financial sector, Financial services and insurance markets will have to find innovative ways to respond efficiently to increasing exposure to climate-related risks. There are already new financial products coming to the market, such as weather derivatives and catastrophe bonds and these need to be further developed. The further integration of European insurance markets under the EU Financial Services Policy and the Solvency II Directive should be pursued as it presents more opportunities both in terms of supply and demand of insurance products. Moreover, the future risk structure of existing public and private natural disaster funds, including the EU Solidarity Fund, needs to be assessed.

Spatial planning could provide an integrated framework to link up vulnerability and risk assessment with adaptive capacities and adaptation responses thus facilitating the identification of policy options and cost-efficient strategies. Consideration should be given to setting up innovative financing arrangements dedicated to adaptation to support the implementation of coordinated adaptation strategies, especially in the most vulnerable regions and sections of society in Europe. The EU has a role in establishing and coordinating assessment frameworks and platforms or networks for information exchange.

Key questions:

- 8) Does section 5.1 correctly and comprehensively identify the needs and policy priorities for early adaptation actions that should either be taken or coordinated at the EU level?
- 9) How do policy priorities need to change for different sectors? Which policy approaches should be taken at national, regional or local level? Where is European action needed?
- 10) How can EU agriculture and fisheries policy be adapted to help these sectors adjust to the impacts of climate change? What will be the likely consequences of climate change for trade in agricultural products?
- 11) How should the EU express its solidarity with regions suffering most heavily from the consequences of climate change?
- 12) How could a collective European response help coastal Europe to tackle the effects of rising sea levels?
- 13) How should EU policy on public health take the impact of climate change into account?
- 14) What will be the consequences of climate change for Member States' potential energy mix and for European energy policy?
- 15) Please rank the listed options under each of the areas of the four-action approach for EU adaptation into the following three categories:
 - a) Most urgent and to be implemented by the Commission as a matter of priority.
 - b) Low priority for Commission implementation.
 - c) Irrelevant for Commission implementation.
- 16) What are the possible synergies between adaptation and mitigation measures? How can these synergies be strengthened?
- 17) In the context of EU policy, how can companies and citizens be encouraged to participate in adaptation actions?

5.2. The second pillar: Integrating adaptation into EU external actions

The growing concern about climate change impacts and resulting adaptation needs will influence EU relations with third countries. Dialogue and partnerships on adaptation must be initiated with developing countries, neighbouring and industrialised countries. While differences in the economic, political, social and environmental situation of partner countries call for specific adaptation strategies, a large number of adaptation actions are similar to all countries, and therefore provide ample opportunity for cooperation.

EU Common Foreign and Security Policy (CFSP) has an important role to play in enhancing the EU's capacity to prevent and deal with conflicts such as border disputes and tensions over access to natural resources and natural disasters accentuated by climate change as well as their potential consequences such as forced migration and internal displacements of persons. EU

migration policy should also take the impacts of climate change into account, in particular in migration management.

Developing countries

Climate change is a serious challenge to poverty reduction in developing countries and threatens to undo many development achievements. Poor communities in these countries depend highly on the direct use of local natural resources. They have restricted choice for their livelihoods and limited capacity to cope with climate variability and natural disasters. The least developed countries in Africa, parts of Latin America and Asia, and small island states will be hit hardest. Climate change could lead to vast displacement of populations, including in regions close to Europe.

Being responsible for most of the historic accumulation of anthropogenic greenhouse gas emissions in the atmosphere, developed countries will need to support adaptation actions in developing countries. Adaptation will be fundamental in securing the achievement of the UN Millennium Development Goals after 2015, especially in sub-Saharan Africa. The European Union must further assess how to integrate adaptation to climate change into existing external policies and funding instruments, and where appropriate design new policies. The EU's experiences with adaptation measures should be shared with developing countries' governments and assistance provided to them to develop equally inclusive approaches. Adaptation should also be integrated into strategies for poverty reduction (i.e. Poverty Reduction Strategy Paper, PRSP), as well as development planning and budgeting. Existing partnerships, such as the ones with China, India and Brazil, provide a good basis for broadening the EU's cooperation on climate change with developing economies.

Adaptation policies and programmes in developing countries can take many different forms depending on countries' specific needs, e.g. diversification of agriculture or livelihoods, improved land-use planning and reforestation, enhanced coastal protection working with wetlands and coastal ecosystems, or strengthening disaster prevention mechanisms. Reducing conventional pressures on ecosystems and making them more resilient to climate change must be the basis for forceful action, together with "climate proofing" to ensure sustainability of investments.

To promote adaptation in developing countries, the European Union should act at both global and European level:

- In the context of the UNFCCC, the EU will continue to advance the issue of adaptation, and promote the integration of adaptation into national development plans (e.g. through the National Adaptation Programmes of Action (NAPA) and also the 5-Year Work Programme on Adaptation recently adopted in Nairobi). EU leadership will be required to help ensure the availability of sufficient financial and technical resources, including through the Adaptation Fund under the Kyoto Protocol, the Global Environment Facility and bilateral channels, to implement NAPAs and similar strategies.
- The 2004 EU Action Plan on Climate Change and Development already includes support strategies for adaptation in developing countries that can, for instance, be supported under the Environment and Natural Resources Thematic Programme and through geographical funds at country and regional level. The inclusion of

adaptation measures in geographical programming will have to be strengthened. The next occasion for this is the mid-term review of country and regional strategies in 2010. The ongoing mid-term evaluation of the Action Plan provides the first opportunity for review of the plan in the light of accelerating climate change.

- The Commission is examining how to promote an enhanced dialogue and cooperation between the EU and developing countries on climate change, through the building of a Global Climate Change Alliance. The Commission has earmarked a total of € 50 million over the period 2007-2010 for dialogue activities, and to support developing countries through targeted mitigation and adaptation measures. Actions could include providing follow-up to the National Adaptation Programmes of Action through concrete pilot projects in particular regarding integration of adaptation activities in key sectoral policies. Moreover, the forthcoming EU strategy on Disaster Risk Reduction will build a bridge between adaptation and disaster response.

Neighbouring countries

The EU should involve Russia, Europe's far North, Greenland, the Black Sea, the Mediterranean Basin, the Arctic and the Alpine region into adaptation efforts. This applies in particular to cross-border issues such as regional seas, river basin management, ecosystem functioning, research, biodiversity and nature, disaster management, human health, economic transition, trade and energy supplies. Neighbouring countries should be encouraged and supported in analysing impacts, risks, vulnerabilities and suitable responses and in including adaptation in their development plans. Actions with neighbours should build on strengthening of existing cooperation, dialogues and processes, in particular in the context of the European Neighbourhood Policy (ENP) where regular and structural dialogue, including with regard to climate change related issues, takes place already in the context of the mutually agreed action plans established to date. The European Neighbourhood and Partnership Instrument (ENPI) could support adaptation projects for the ENP countries and Russia. In the candidate and potential candidate countries, the Instrument for Pre-Accession Assistance could be used.

Industrialised countries

Impact analysis and good adaptation practices should be exchanged between industrialised regions facing similar problems, for example, in Japan, Southeast Australia, and Southwest US. Cooperation strategies with these countries should be further elaborated.

Enhancing trade in sustainable goods and services

The Commission is working towards a global market for environmental technologies that fosters trade in sustainable goods and services as well as technology transfer, especially between industrialised and developing countries. An important way of achieving this is by using our multilateral and bilateral trade negotiations to address the question of trade and investment in green technologies and environmental goods and services in a cooperative and incentive-based approach.

Key questions:

- 18) How will climate change affect the policy priorities of the EU's external policies?
- 19) Which priorities should the EU set for its co-operation programmes in the different parts of the World with respect to adaptation to climate change?
- 20) Which are the main opportunities and obstacles for adaptation in different parts of the World?
- 21) What are the best options to make the EU's external action more resilient to climate change?
- 22) What could be the value added for EU action compared to other international initiatives including, for instance, the UNFCCC and multi-lateral funding instruments?

5.3. The third pillar: Reducing uncertainty by expanding the knowledge base through integrated climate research

Sound scientific results are paramount in the development of climate policy. Although considerable progress has been made in understanding the earth-climate system, uncertainties remain particularly in relation to more accurate and detailed forecasts as to the impacts of climate change at regional and local levels, cost and benefits of adaptation measures for shorter time frames such as 2020-2030. An integrated, cross-sectoral and holistic approach is to be promoted together with internalisation of environmental costs of physical and biological system degradation. Research should address the complexity of interrelated factors which cannot be analysed independently. The EU's 7th Framework Programme for Research (2007-2013) places a strong emphasis on climate change, both in terms of predictive capacity, modelling and adaptation strategies. Major projects are described in Annex 4. The research agenda on adaptation and climate change will consider, inter alia, the following aspects:

- Develop comprehensive and integrated methodologies for the assessment of impacts, vulnerabilities and cost effective adaptation. Develop indicators to measure the success of responses. Improve European-wide risk, impact and cost/benefit assessment for adaptation responses, as compared with "no action". Compare integrated EU-wide responses with sectoral approaches including analysis of socio-economic costs and benefits. Improved integrated assessment and the development and use of tools for demonstrating economic, environmental and social benefits of adaptation for European regions crossing national boundaries.
- Improve the basic understanding and prediction of impacts in Europe, including in the North Atlantic, the Arctic, the Mediterranean and the Black Sea. Downscale climate models and improve predictions of impacts on a regional and local scale, including potential impacts on the water sector, the energy sector (reduced cooling capacity for power plants, impacts on hydropower, increased demand for cooling of buildings), on transport infrastructure, industries and businesses, land-use planning, agriculture and human health.
- Clarify the expected impacts of climate change and ozone layer depletion on ecosystems and explore ways to enhance their resilience. This should include an assessment of climate impacts on carbon stocks in soils and the biosphere in general, impacts on aquatic

ecosystems, the influence of agro-ecological management practices and an assessment of the habitats, species and natural resources most at risk.

- Long term comprehensive and Europe-wide high resolution datasets and models are needed. Coordination between data centres, information systems and networks should be improved.
- Improve access to existing data and integrate data relevant for adaptation into INSPIRE (Infrastructure for Spatial Information in Europe), SEIS (Shared Environment Information System) and GMES (Global Monitoring for Environment and Security), including inter alia substantially strengthened long-term *in situ* monitoring of quality and quantity aspects of natural resources, biodiversity and ecosystem services.
- The use of existing Community-supported information systems, e.g. European Flood Alert System, European Forest Fires Information System, and the Monitoring and Information Centre (MIC) for civil protection, the EC Crop Yield Forecasting System must be encouraged and brought to full potential, e.g. by linking them to a suitable European Meteorological data infrastructure and dedicated monitoring programmes. Improve policy-relevant information by the European Data Centres on air quality, natural resources, human health, products and waste, taking a life-cycle perspective.
- Provide every 4-5 years up-to-date synthesis reports on climate impacts, adaptation and vulnerabilities to be produced by the European Environment Agency and the Joint Research Centre, based inter alia on the results from the EU Research Framework Programmes and national research.
- In cooperation with the private sector, support research on adaptation for businesses, services and industries. Launch research for development of adaptation technologies and products to stimulate innovation in different sectors (e.g. agriculture, forestry, water, energy, construction, fisheries and aquaculture).
- Launch Europe-wide studies on the present and future plans of coastal regions to strengthen coastal protection, the environmental and economic costs involved in these plans, the impacts they may have on the community budget and on the economy of coastal regions. This should include the assessment of costs involved for ports and waterways to continue delivering basic transport functionalities.
- Improve knowledge on flows and availability of resources world-wide, including renewable energy resources. Provide independent scientific assessment of environmental impacts due to the use of natural resources and on resource efficiency. Best use should be made of the analysis inter alia from the International Panel on the Sustainable Use of Natural Resources and the IPCC reports.
- Promote co-operation, partnerships and networking with the scientific community in EU and non-EU countries, particularly developing countries, neighbours and key partners, and share research results, climate models and other methodological tools, especially in the context of the five-year work programme on adaptation under the UNFCCC.
- Provide support to practitioners through guidance on existing scientific knowledge and adaptation measures, options and cost-benefit analysis of these options. Promote Europe-wide networks for the exchange and consolidation of knowledge, experience and adaptation in Europe. Facilitate transmission of knowledge from the research community to practitioners.

Modern Information and Communication Technologies (ICT) and their further developments will be a key instrument to support this adaptation process, enabling relevant, flexible and speedy responses to the adaptation requirements for example for monitoring environmental changes, anticipating and assessing risks, managing crisis situations.

Key questions:

- 23) Do the listed research areas address the most important knowledge gaps? If not, please add?
- 24) Which are the five most important research areas that need to be addressed as a matter of priority?
- 25) How should research results be communicated and made available to decision makers and a broader public at local, national, EU-level and internationally?

5.4. The fourth pillar: Involving European society, business and public sector in the preparation of coordinated and comprehensive adaptation strategies

The need for adaptation could provoke significant restructuring in some economic sectors that are particularly weather dependent, e.g. agriculture, forestry, renewable energy, water, fisheries and tourism, or specifically exposed to climate change, e.g. ports, industrial infrastructure and urban settlements in coastal areas, floodplains and mountains. There should be a structured dialogue with the parties and civil society concerned to explore these challenges systematically. They could exchange views and provide advice on comprehensive and coordinated strategies, including possible restructuring and accompanying measures.

As part of the European Climate Change Programme (ECCP) the Commission will consider the establishment of a European Advisory Group for Adaptation to Climate Change which should operate as a Commission's Expert Group and consist of representative policy-makers, leading scientists and civil society organisations. It would comment on the work of a number of specific working groups over a period of 12 months starting in November 2007.

This stakeholder consultation process could cover the following topics: water, biodiversity, agriculture and forestry, marine resources, industry, public health, transport, energy, research, technology and innovation, financial services and insurance, cohesion policy and regional funds, external action and co-operation with non-EU countries, use of land use instruments and spatial planning. The Commission could provide a secretariat and chair the different working groups. The European Advisory Group could present its first report in mid-2008 on which the Commission may draw during the development of its Communication on adaptation to be presented by the end of 2008.

Key question:

- 26) Does the Green Paper foresee sufficient participation of the different stakeholders in identifying and implementing EU adaptation actions?
- 27) Should stakeholders from the EU's neighbours and other regions be involved?
- 28) Would the establishment of a European Advisory Group on Adaptation be helpful in further exploring an EU response to the effects of climate change? If yes, which areas should such an Advisory Group concentrate its work on?

6. NEXT STEPS

All parts of Europe will increasingly feel the adverse effects of climate change. Adaptation efforts have to be stepped up at all levels and all Community policies and need to be well co-ordinated.

Public feedback is requested on the key questions raised at the end of the main chapters of the Green Paper. The European Institutions and all those interested – organizations or private individuals – are invited to contribute to the public EU-wide debate that will be launched with the adoption of the Green Paper:

- The Green Paper will be launched publicly after adoption in Brussels.
- A web-based public consultation will be open until 30 November 2007.
- In order to allow for a more direct exchange of views, the Commission will organise workshops on this Green Paper in several Member States and, where appropriate, in third countries.

The results of the public consultation will help shape the further work of the Commission in particular regarding the planned Commission Communication on adaptation and a further elaboration on other Community policies and the external policy action.